

CLAIMS

1. An electric-field distribution measurement method for a semiconductor device, comprising:

a holding step of applying a predetermined voltage to a semiconductor device on which a two-dimensional circuit is formed, and holding the semiconductor device in an applied state;

an irradiation step of irradiating a laser beam having a predetermined wavelength onto the two-dimensional circuit of the semiconductor device, which is held in the applied state, so as to scan it two-dimensionally;

a detection/conversion step of detecting an electromagnetic wave, which is radiated from a laser-beam irradiation position on said semiconductor device to which said laser beam is irradiated, and converting the electromagnetic wave into an electric-field signal, which changes temporally; and

a judgement step of judging the phase of the electric-field signal which changes temporally, and the electric-field distribution measurement method for the semiconductor device being characterized in that the electric-field direction distribution of said semiconductor device is measured using the fact that the phase, which is judged in said judgement step, depends on the electric-field direction at the laser-beam irradiation position.

2. The electric-field distribution measurement method for a semiconductor device set forth in claim 1 being characterized in that it further comprises a sampling step of sampling the amplitude of an electric field at a predetermined time in said electric-field

signal, which changes temporally, and an electric-field strength distribution is measured as well using the fact that the amplitude of the electric field, which is subjected to sampling in the sampling step, is proportional to the strength of the electric field at said laser-beam irradiation position.

3. The electric-field distribution measurement method for a semiconductor device set forth in claim 2 being characterized in that the predetermined time of the sampling step comprises a plurality of times; and the sampling step carries out sampling the amplitude of the electric field at the plurality of times, thereby measuring the electric-field strength distribution at different times.

4. The electric-field distribution measurement method for a semiconductor device set forth in either one of claim 1, 2 and 3 being characterized in that said laser beam is one which is modulated with a predetermined frequency.

5. The electric-field distribution measurement method for a semiconductor device set forth in either one of claim 1, 2, 3 and 4 being characterized in that the predetermined voltage of said holding step comprises a voltage, which is modulated with a predetermined frequency; and said detection/conversion step converts an electromagnetic wave, which is modulated with the modulated frequency, into an electric-field signal, which changes temporally, thereby measuring the electric-field distribution of a circuit portion to which the modulated voltage is applied.

6. The electric-field distribution measurement method for a semiconductor device set forth in either one of claim 1, 2, 3, 4 and 5 being characterized in that said irradiation step irradiates said laser beam onto said two-dimensional circuit so as to scan it two-dimensionally by way of a near-field optical system.

7. The electric-field distribution measurement method for a semiconductor device set forth in either one of claim 1, 2, 3, 4, 5 and 6 being characterized in that said predetermined wavelength of said irradiation step is selected so that said laser beam is absorbed by the material of said semiconductor device.

8. An electric-field distribution measurement apparatus for a semiconductor device, comprising:

a voltage-application apparatus for applying a predetermined voltage to a semiconductor device on which a two-dimensional circuit is formed, and holding the semiconductor device in an applied state;

a laser apparatus for generating a laser beam having a predetermined wavelength;

an irradiation apparatus for irradiating the laser beam onto the two-dimensional circuit of the semiconductor device, which is held in the applied state, so as to scan it two-dimensionally;

an electromagnetic-wave detection/conversion apparatus for detecting an electromagnetic wave, which is radiated from a laser-beam irradiation position on said semiconductor device to which said laser beam is irradiated, and converting the electromagnetic wave into an electric-field signal, which changes

temporally; and

phase-judgement means, to which the temporally-changing electric-field signal output from the detection/conversion apparatus is input, for judging the phase of the electric-field signal, and

the electric-field distribution measurement apparatus for the semiconductor device being characterized in that it measures the electric-field direction distribution of said semiconductor device using the fact that the phase, which is judged by the phase-judgement means, depends on the electric-field direction at the laser-beam irradiation position.

9. The electric-field distribution measurement apparatus for a semiconductor device set forth in claim 8 being characterized in that it further comprises electric-field amplitude sampling means, to which said temporally-changing electric-signal output from the electromagnetic-wave detection/conversion apparatus is input, for sampling the amplitude of an electric field at a predetermined time in said electric-field signal and it measures an electric-field strength distribution of said semiconductor device as well using the fact that the amplitude of the electric field, which is subjected to sampling by the sampling means, is proportional to the strength of the electric field at the laser-beam irradiation position.

10. The electric-field distribution measurement apparatus for a semiconductor device set forth in claim 9 being characterized in that said electric-field amplitude sampling means carries out sampling the amplitude of the electric field at a plurality of

predetermined times, and thereby measures the electric-field strength distribution at different times.

11. The electric-field distribution measurement apparatus for a semiconductor device set forth in either one of claim 8, 9 and 10 being characterized in that it comprises modulation means for modulating said laser beam with a predetermined frequency.

12. The electric-field distribution measurement apparatus for a semiconductor device set forth in either one of claim 8, 9, 10 and 11 being characterized in that said voltage-application apparatus applies a voltage, which is modulated with a predetermined frequency, to said semiconductor device; and said electromagnetic-wave detection/conversion apparatus converts an electromagnetic wave alone, which is modulated with the modulated frequency, into an electric-field signal, which changes temporally, and thereby measures the electric-field distribution of a circuit portion to which the modulated voltage is applied.

13. The electric-field distribution measurement method for a semiconductor device set forth in either one of claim 8, 9, 10, 11 and 12 being characterized in that said irradiation apparatus comprises a near-field optical system, and thereby irradiates said laser beam onto said two-dimensional circuit so as to scan it two-dimensionally by way of the near-field optical system.

14. The electric-field distribution measurement apparatus for a semiconductor device set forth in either one of claim 8, 9, 10, 11,

12 and 13 being characterized in that said laser apparatus generates a laser beam with a wavelength which is absorbed by the material of said semiconductor device.